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WOODS HOLE OCEANOGRAPHIC INSTITUTION
Woods Hole, Massachusetts 02543

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Valentine Worthington, Chairman
Department of Physical Oceanography

Field Experience with Acoustic Releases at the Woods Hole Oceanographic Institution

by

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Introduction

The Buoy Project at the Woods Hole Oceanographic Institution has accumulated seven years of field experience with the acoustic release system built by American Machine and Foundry (AMF). In 1967, as a result of a testing program conducted to select a release system (Heinmiller, 1968) the AMF system was selected as the sole anchor-release device used on Buoy Project moorings. Through December of 1976 this system has been deployed a total of 328 times in various mooring configurations. While release failures are sometimes difficult to separate from other problems, particularly in the case of subsurface moorings, we have had excellent reliability.

Background

The first AMF acoustic releases purchased and used at sea by the Buoy Project were of the non-transponding type but included, in addition to the release function, a timed pinger which confirmed release, and a back-up timer. Later models included the transponder. For details of the configuration of the release system the relevant AMF manuals should be consulted (AMF, 1971). As experience accumulated, releases were

*On leave of absence from the Woods Hole Oceanographic Institution

purchased without the back-up timers and the timers in our stock of releases were removed to increase the battery capacity. The model presently being purchased includes a double battery pack (designated by AMF as a "two-year battery") to provide a margin as duration of moorings at sea is increased toward a year. Non-transponding releases have been retired from general use. Complete maintenance and field procedures have been collected into a technical report, which includes discussions of modifications made here (LaRochelle, 1974) designed to supplement the AMF manuals.

The Project currently maintains a stock of forty-six operational releases. Thirteen of these are of the discontinued model 263. Numerous changes have been made on these units to upgrade their reliability to match current models. These releases are used on all types of moorings deployed by this Project (Walden and Heinmiller, 1974). In 1973 a total of thirteen releases were used on one installation on the Internal Wave Experiment (Tri-moor) (Moller, 1974).

Release Maintenance

Before use, each release is put through a stringent check-out procedure, including a cold-room check. Before every deployment new batteries are installed and each release is test-lowered at sea down to 3,000 meters and run through a set of standard acoustic checks. Shipboard equipment is maintained by us but is periodically sent back to AMF for overhaul.

Special emphasis is placed on the dissemination of information in the preventive maintenance of the equipment to all users of releases here as well as at other oceanographic installations. To date over 150 copies

of Technical Report WHOI 74-45 (LaRochelle, 1974) have been sent to requesting agencies. In addition, training of maintenance personnel has been provided to representatives of other organizations as well as our own. Information about technical or operations problems has been furnished to the release manufacturer for corrective action and/or notification of users through their service bulletins.

In an area as critical to mooring reliability as the acoustic release, rapid exchange of data on problems and solutions could make the difference between a success and a failure at sea. Toward this end, in cooperation with the manufacturer, a users group has been established to facilitate exchange of information directly between users. Anyone interested in participating should write Keith F. Bradley at WHOI.

Field Operations

Three complete sets of shipboard gear are owned by the Project, plus extra transducers. Two complete sets are always carried on a cruise to provide back-up, plus a range/direction receiver. One standard transducer and the directional transducer are usually hull-mounted. Flanges have been built (Fig. 1) to adapt the transducers for mounting in the standard echo-sounding transducer flanges on the ship. All of the Institution's ships have air-locks over the transducers so the units may be mounted for each cruise and removed immediately afterward. Each unit includes a free-flooding fiberglass housing to protect the transducer (Fig. 2). Since this housing has to be fairly thick to withstand the force of water at full ship's speed, it attenuates the signals somewhat. However, this is not felt to be a serious problem. Most operations,

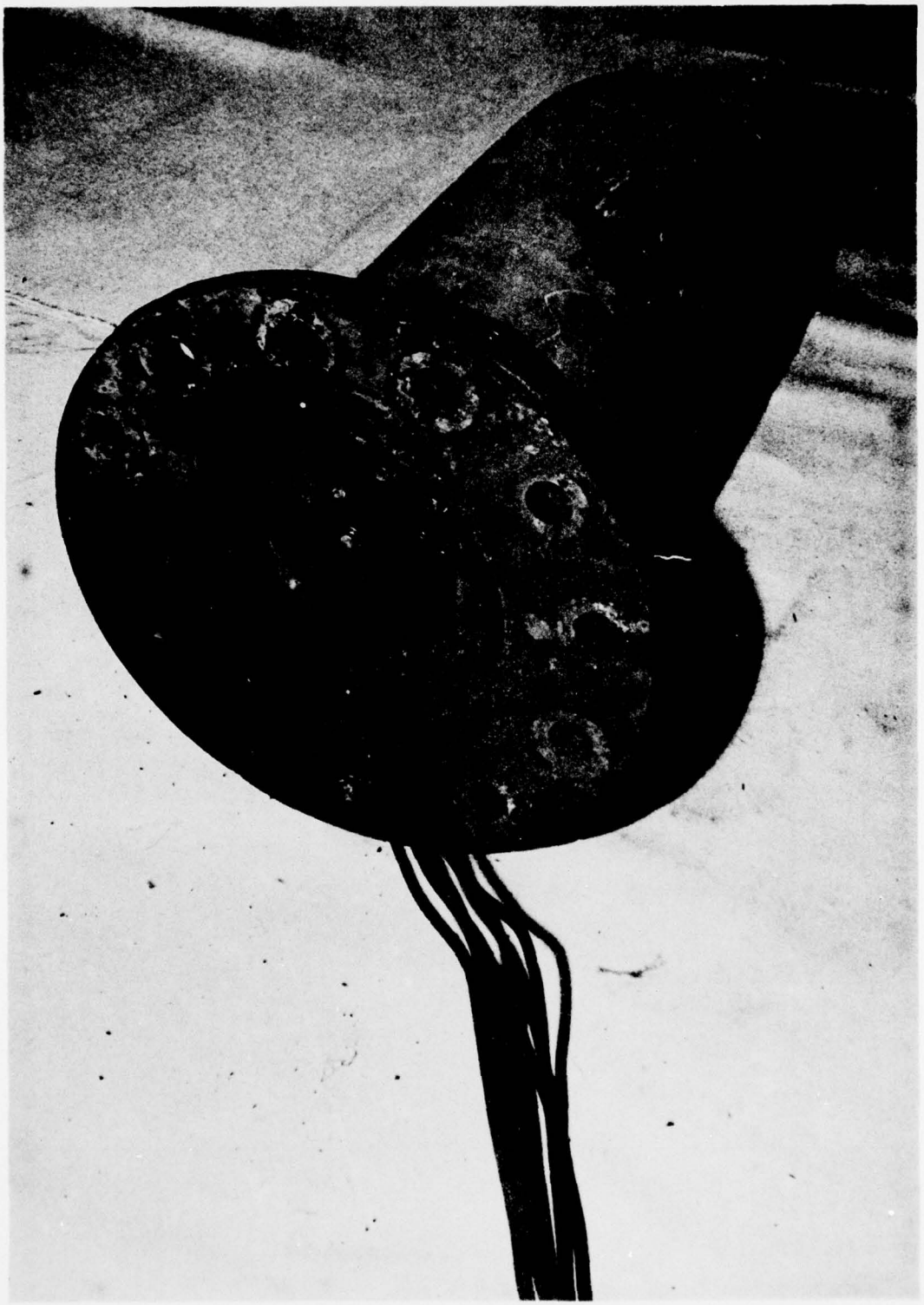

Figure 1

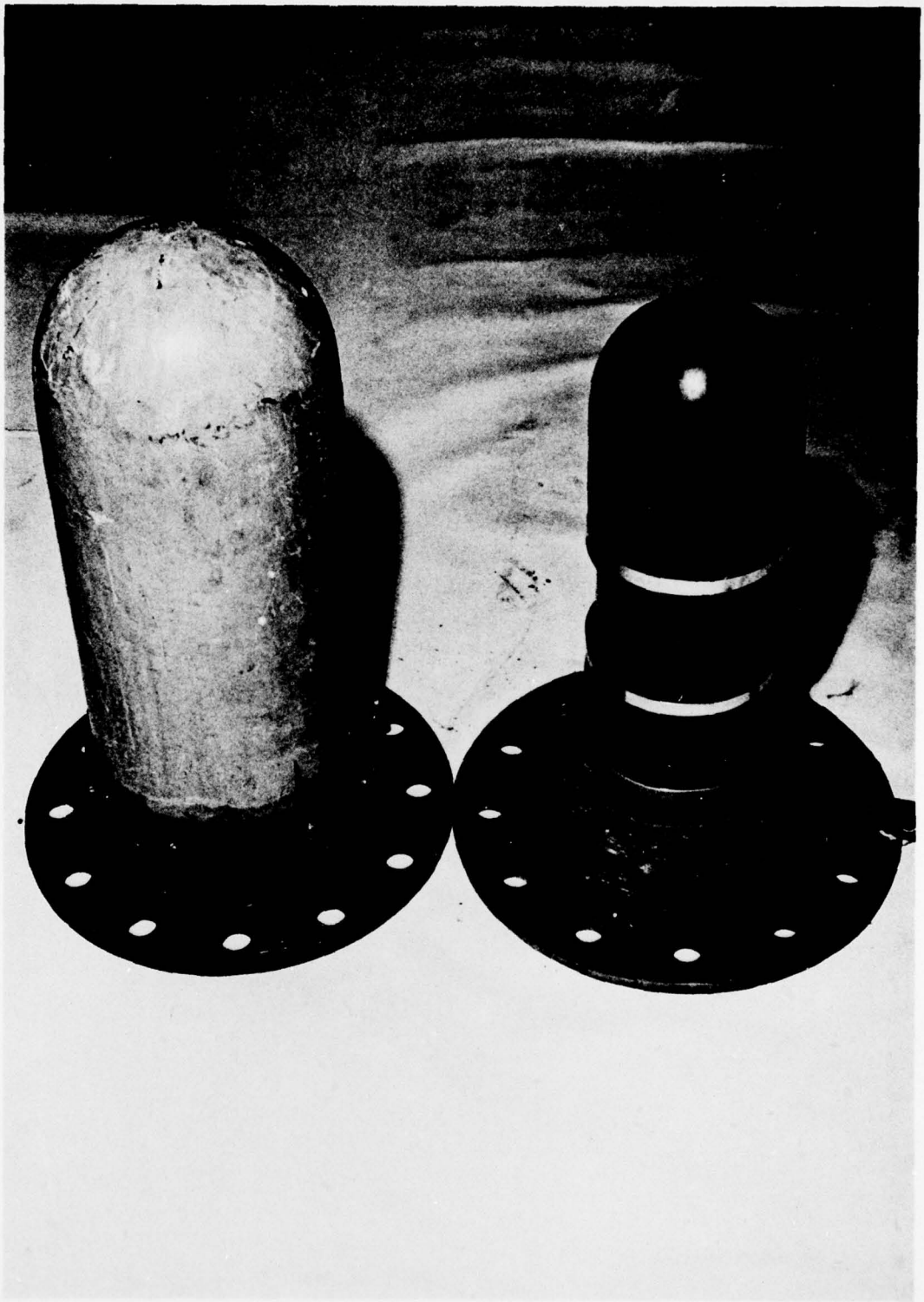

Figure 2

including both release triggering and location, are done through the directional array, the standard transducer being a spare. At least one transducer on a cable for the over-the-side use is also carried.

Transducers previously used by us required that the ship be stopped so that the transducers could be put over the side. The present system's hull-mounted transducers and transponding releases allow more flexibility and speed and are a significant factor in successful mooring recoveries during adverse sea condtions.

Besides the tests on the wire before launch, a set of tests of the release functions is carried out after the mooring has bottomed out. A further series is made just before release and recovery, when feasible. The results of all tests are recorded on a standardized form. These tests are designed to provide information on release performance in all modes. Complete histories are compiled on all units.

Field Reliability

As shown in the table we have deployed AMF releases at sea 328 times. (Some moorings for engineering tests have carried more than one release.) Under "Possible Failures" are tabulated all events for a given release type which could be interpreted as release failure, even though in some of these cases failure to recover the mooring may have been due to other causes. In this category are fifteen deployments for a failure rate of 4.6%.

Particularly with subsurface moorings it may not be possible to determine if a release failure has actually occurred. If, upon arrival at the mooring location to recover the mooring, no response at all is had from the release, either the release batteries could have failed

completely or the mooring may have parted below the release and drifted away. Experience on the MODE-I operations has revealed a possible cause of the latter type of loss. During the deployment of the MODE-I array, two moorings parted below the release at a nylon anchor tag line, apparently when the tag lines became tangled in the release case. Both failed during anchor free-fall and were recovered immediately and reset. Five meters of chain are now used below the release as a chafe link to prevent this. However, it is possible that this type of failure had occurred on earlier moorings with the tag line not being damaged enough to fail until some time after the deploying vessel had left the area (Heinmiller, 1975). Another cause could be drifting of moorings due to high currents. A "missing" mooring was recently located and recovered 5.5 miles from the position at which it had been set.

In the column "Probable Failures" are tabulated the number of occasions on which it is definitely known that a release failed or in which an evaluation of the circumstances seemed to point strongly to such a failure. (In the latter cases, admittedly a certain amount of subjective judgment is involved.) In one case, for instance, it was discovered after deployment that a squib had been miswired due to a misunderstanding in a verbal communication with the manufacturer. A total of eight of this general class of failures has been experienced for a failure rate of 2.4%. Included in this total is one release intended for a twenty-four hour deployment which refused to release until seven months later, apparently due to a sticky reed switch in the transmit/ receive circuitry. Not included in either of these totals, however, are occasions on which the release device was "balky" and refused to

release for periods of up to a few hours but eventually yielded to persistent efforts to trigger it. This can occur due to poor acoustic-path conditions, marginal shipboard gear, or marginal underwater equipment. Not included are deployments in which some secondary function (pinger or transponder) of the release failed at some point in the operation, but where the device performed its primary function, that of releasing the anchor for recovery of the mooring. Also not included in the table are data on the performance of the releases used for short durations with no instrumentation or those loaned to other departments or agencies. No losses were incurred in these deployments which numbered approximately twenty-five during 1974, 1975, and 1976.

Before the April 1975 cruise no failures had been experienced with the releases in the previous 108 deployments. On this cruise two releases were lost. The cause of these failures has not been determined but present evidence indicates that release was effected but the moorings could not be found due to loss of the pinger battery and failure of other recovery aids.

Summary

The Buoy Project at Woods Hole has achieved, in seven years of acoustic anchor-release use and 328 deployments at sea, a reliability rate of approximately 95%. The actual reliability of the release devices may be considerably better than that figure due to the difficulty of identifying release failures separately from other mooring hazards. This record indicates that when properly maintained and used at sea this system is sufficiently reliable for large-scale, long-term use at sea.

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TABLE

Failures by Type

Release Type	Total Deployments	Possible Failures	Probable Failures
Non-Transponding	41	4	2
Transponding	287	11	6
	328	15 or 4.6%	8 or 2.4%

* * * * * *

Total Deployments by Year

Year	Non-Transponding	Transponding	Total	Unknown or Failures
1967	1	0	1	0
1968	13	1	14	1
1969	14	15	29	1
1970	6	37	43	5
1971	6	47	53	3
1972	0	58	58	3
1973	1	44	45	0
1974	0	43	43	2
1975	0	36	36	0
1976*	0	6	6	0
			328	15

*21 deployments during 1976 and scheduled to be recovered during 1977 are not included in the above tabulations.

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